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A PROGRESS REPORT ON THE EFFECT OF ZINC AS A CONSTITUENT OF POTATO FUNGICIDES[1]

L. C. CALLBECK[2]

In 1870, Raulin (22) reported that the growth of the fungus, *Aspergillus niger,* was stimulated by the addition of zinc salts to the nutrient solution; in 1908, Javillier (18) established the essential nature of zinc in the nutrition of chlorophyll-containing plants; and confirmations of his studies were published by Sommer (27) and by Sommer and Lipman (26) who, however, presented no detailed discussion of the appearance of the plants without it. The symptoms of zinc deficiency in potato plants were studied by Schreven (25) in extensive and carefully conducted water culture experiments by means of which he showed that potato plants deprived of the element were stunted and exhibited necrotic spots on the leaflets. Dostal (11) reported that zinc increased considerably the growth of potato seedlings in solution cultures. Symptoms of zinc deficiency, so far as is known, have never been reported as occurring on the potato under field conditions, although they have been observed on a number of other plants.

The results of fertilizing potato soil with zinc salts, and with zinc-containing fertilizers, have not been encouraging. From a study of fourteen experiments with the use of the sulphates of copper, manganese, and zinc in fertilizer mixtures for potatoes, Hester and Carolus (14) reported that no significant increase in yield was produced. Yield data, reported by Morgan (21) in Western Australia, indicate that no benefit was derived, as measured by yield, from the inclusion of zinc, or of certain other minor elements, in potato fertilizer mixtures. During a 6-year period, adding carriers of Ca, Mg, Na, Mn, Zn, B, and Cl to a fertilizer containing only NPK did not increase the yields in tests conducted by Brown (7) in Connecticut. The elements were added alone and in combination. In tests conducted along similar lines in the Red River Valley of Minnesota, Rost, Kramer, and McCall (24) obtained no significant increases in yield. Experiments in Maine by Terman and Hawkins (28) made a comparison of the effect of fertilizer containing none or only trace amounts of zinc with fertilizer containing twenty pounds of zinc sulphate per acre. In two of their four tests, the zinc salt had no effect on yield; but in the other two tests, zinc increased yields by 32 bushels in plots where potatoes were grown every year, 11 bushels in plots where potatoes were grown alternately with crimson clover, and 2 bushels in plots of a similar rotation with millet. Working in the same State, Bonde and Robinson (6) reported that zinc sulphate, added to the soil about the plants, did not increase yield nor stimulate growth. Substantial increases in yield were obtained by the Rhode Island Agricultural Experiment Station (23) by soaking cut seed pieces for thirty seconds in the zinc-containing fungicide, Zerlate. The seed pieces treated in this preparation emerged earlier than those treated with four other materials, which did

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not contain zinc, or the check, and yielded 34 bushels per acre over the check.

The direct application of zinc by spraying carriers of the element on the foliage has produced more favorable responses. Ellis (12) obtained significantly higher yields in three out of four years by including zinc sulphate in the regular copper-lime spray. He observed that, although soil applications of zinc sulphate had indicated no response, some effect was induced by the zinc-containing sprays, for the foliage acquired a bluish-green cast. Later, the same author (13) reported that higher yields may be expected from potatoes sprayed with the zinc-containing fungicides Dithane D-14, Dithane Z-78, and Parzate than from those sprayed with copper fungicides, even though the degree of disease control may be analogous. Similar results have been obtained in Ontario by Berkeley, Thompson, and Richardson (1,2). The addition of zinc sulphate to Copper Oxychloride Sulphate, Copper-A, and Fermate resulted in larger yields than when these fungicides were used alone. The results of experiments by Hoyman (17) have shown that the yields of potatoes grown in the Red River Valley of North Dakota were increased by applying zinc-containing dusts and sprays to vines that showed no external symptoms of zinc deficiency. He observed that the vines in plots treated with the zinc-containing materials were greener at the time of the first killing frost than vines in other plots. An examination of the plants indicated the presence of considerable new foliage. Although the foliage was not weighed, nor the degree of color recorded, there was a positive correlation between the yields and the amount of green foliage exhibited in kodachromes taken one week previous to frost. Bonde and Robinson (6), on the other hand, have reported that zinc sulphate added to copper sprays did not improve the yield rate nor stimulate growth in their tests in Maine.

The literature is replete with conflicting reports regarding the influence of various potato fungicides on yield, and many hypothesis have been expounded. Horsfall and Turner (16) hold that dithiocarbamates are not much, if any, better than Bordeaux in the control of late blight, but they claim that the yield of potatoes is increased. These authors suggest that this is caused by a lower level of phytotoxicity which, in turn, is caused by a low lime content. In this opinion they are supported by Heuberger (15) who suggests that increased yields obtained through the use of zinc-organic fungicides, when late blight is not a factor, are brought about mainly by the fact that these fungicides are not so phytotoxic as the copper fungicides in common use. Although the lime may have some influence as shown by Mader (19), Blodgett *et al* (3,4), Bonde (5), and Callbeck (8,9), it is possible that the zinc in the organic fungicides tested was a factor contributing to the increased yields.

Two experiments with Bordeaux and Dithane D-14 plus zinc sulphate have been conducted in Prince Edward Island. Under severe late blight conditions in 1951 (10), plots sprayed six times with Bordeaux showed 53 per cent defoliation on the 14th of September; plots sprayed six times with Dithane D-14 showed 100 per cent defoliation; those sprayed ten times with the latter fungicide showed 39 per cent defoliation; the unsprayed controls were completely defoliated one week earlier. The yields were in the same order, being 333.5, 311.5, 394.3, 257.8 bushels per acre, respectively. Differences required for significance were: 36.38 at

the 5 per cent level, and 66.81 at the 1 per cent level. In 1953 (10), four treatments were studied: (a) Bordeaux all season, (b) Dithane D-14 all season, (c) Dithane D-14 during the first part of the season and Bordeaux during the second part, (d) unsprayed check. The treatments of the first part of the schedule were applied July 20, 30, August 10, 20, and those of the second part on August 27, September 3, 10. Two storms, particularly the second, which occurred on Labor Day, caused considerable damage to the plants in all plots that had received Bordeaux treatments, and this damage may be reflected in the yields. None of the spray plots was severely attacked by late blight, the percentages of defoliation on the 15th of September being 7 for the Bordeaux schedule, 9 for the Dithane D-14 schedule, and 16 for the split schedule. The unsprayed controls were dead on that date. Total yields in bushels per acre were: 352.6, 420.7, 390.9, 291.5 respectively. Differences required for significance were: 31.33 at the 5 per cent level, and 44.88 at the 1 per cent level.

The annual reports of the Potato Fungicide Committee (10) present some information on the influence of zinc-containing fungicides on yield. One such material, Parzate, was tested at Fredericton, New Brunswick, and Charlottetown, Prince Edward Island, in a cooperative test in 1949. At Fredericton, in the absence of blight, this fungicide gave the highest yield; and at Charlottetown, despite the severe defoliation caused by disease, it ranked second. Of the six fungicides screened at Charlottetown in 1949 (with Bordeaux included as a standard), Cop-O-Zinc and Crag 658 gave the highest yields. In 1950, Bordeaux, Basi-Cop, Crag 658, Dithane D-14, and Phygon XL were tested on a co-operative basis in British Columbia, Quebec, New Brunswick, and Prince Edward Island. The summary (10) of the results shows that Dithane D-14 and Crag 658 placed first and second, respectively, with regard to yield. Dithane Z-78, the only zinc-containing fungicide in the 1950 Screening Test at Charlottetown (10) ranked first in yield.

Experiments and Results

A. Seed Piece Treatment

A preliminary study of the effect of zinc on the growth of potatoes was conducted in the greenhouse during the winter of 1949-1950. One hundred Green Mountain tubers of similar size and shape were selected as seed sources. Each tuber was cut transversely, the stem-end portion was discarded, and the eye-end portion was cut horizontally into two equal seed pieces, one of which was placed in the check lot, the other in the treated lot. Treatment consisted of immersing the seed pieces for one minute in a solution of zinc sulphate at a concentration of 5 pounds per 100 gallons of water. An equal volume of soil was placed in each of 200 pots, the seed pieces were placed with the eye-end up, and equal volumes of soil were used to cover them. Thus the seed pieces were uniform with respect to size, shape, position of eyes, position in soil, and depth of cover. The pots were completely randomized to offset moisture, temperature, and light variations.

When the plants began to appear, the emergence rate was tabulated by making daily counts. It was found that plant emergence was more

rapid from the seed pieces that had been treated with zinc sulphate solution, 100 per cent emergence being reached two days earlier than with the untreated seed pieces. A second test was set out and the results again showed a two-day difference in plant emergence.

This phase of the study was pursued further in the field in the summer of 1950, and three treatments were employed: (a) check, (b) seed pieces immersed for one minute in a solution of zinc sulphate at 5 - 100, (c) seed pieces immersed for one minute in a solution of zinc sulphate at 10 - 100. Each plot consisted of a single row of 30 Irish Cobbler seed pieces, and the treatments were replicated six times. The planting was made at the beginning of a dry, hot period, emergence was retarded, and a number of seed pieces decayed. Fifteen days after the first shoots were observed, the plants in the check rows had reached a constant emergence of 86.3 per cent. Thus 13.7 per cent of the untreated seed pieces decayed and failed to produce plants. A maximum plant emergence of 97.9 per cent was shown by the seed pieces treated with 5 - 100 zinc sulphate solution two days earlier than the checks; whereas the seed pieces treated with 10 - 100 zinc sulphate solution reached a maximum emergence of 96.8 per cent three days earlier than the checks reached their maximum emergence.

The plants produced from zinc-treated seed pieces developed heavier growth than the plants arising from untreated seed pieces, and, in the latter case, partial decay of many seed pieces may have resulted in weak plants. Unfortunately most data on this field experiment were lost in the laboratory fire.* Included in this material were some excellent photographs that showed very obvious differences between the growth of the plants in the treated and untreated rows. The results presented above suggest that zinc sulphate may have certain value in preventing seed piece decay under certain conditions. Millikan (20) found that soil applications of zinc sulphate assisted cereal plants in withstanding the deleterious effects of certain microorganisms, but he did not determine whether this effect was caused by the zinc sulphate affecting the nutritional status of the plants or by its fungicidal action.

Similar, but more elaborate field tests were conducted in 1951, 1952, 1953. In each of these years good growth conditions prevailed when the plantings were made, and no differences in emergence rates or growth rates were observed. The results, however, show that higher yields were produced in those plots in which zinc-treated seed pieces were planted. In these years, Green Mountain seed was used, the solutions were prepared at 0.08N, the checks were treated in distilled water, hydrogen counterparts of the zinc salts were used in the comparisons, a plot consisted of a 50-foot row, and the replications were 4 in 1951, and 6 in 1952 and 1953. The plots were sprayed with Copper Oxychloride Sulphate and DDT to control late blight and insects, and were destroyed at the appropriate time by spraying them with sodium arsenite solution. The yield results are presented in table 1.

B. Soil Treatment

The effect on yield of soil applications of zinc compounds was studied for the first time in 1951, and continued in 1952 and 1953. In these

*Building completely destroyed January 31, 1951.

studies, Green Mountain seed was used in each of the years, and 1200 pounds per acre of 5-10-13 fertilizer was incorporated with the soil before planting. Twelve single-row plots, each 50 feet long, were planted on the 1st of June, 1951, and zinc sulphate was sprinkled in the drills of six of them before the seed pieces were covered. The application was made at the rate of 1.0 gram of zinc sulphate per seed piece, equivalent of 28.8 pounds per acre. The mean yield for the six plots fertilized with the zinc salt was 289.1 bushels per acre or 21.2 bushels greater than the mean yield of 267.9 bushels per acre produced by the six untreated check plots.

In 1952 and 1953, increased plantings were made in order to include more compounds of zinc in the soil fertilizer test, and it was found that the use of zinc acetate and zinc oxide also resulted in increased yields as shown in table 2. It will be observed in this table that the increases in yield progress in the same order as that of the amounts of elemental zinc.

In a similar test on a farm at Hunter River, zinc compounds increased the yields of the blight resistant varieties Keswick and Kennebec as shown in table 2.

C. Spray Tests

Initial studies of the effect of including zinc sulphate in the late blight spray mixture were conducted in 1950 when four treatments were employed: (a) Check, (b) Basi-Cop, 3.5-80, (c) Zinc sulphate, 2-80, (d) Basi-Cop + zinc sulphate, 3.5-2-80. DDT at the rate of 1.5 lb. of 50W per 80 gallons was added to all sprays, and the check plots were treated with this insecticide on the same days as the copper and zinc

TABLE 1.—*Effect of seed piece treatment on yield of Green Mountain.*

Treatment	Normality	Bushels per Acre (No. 1 Tubers)		
		1951	1952	1953
Distilled H_2O		243.8	367.3	302.2
H_2SO_4	0.08	245.3	378.6	291.1
$ZnSO_4$	0.08	255.5	396.4	317.2
$HC_2H_3O_2$	0.08		391.0	284.4
$Zn(C_2H_3O_2)_2$	0.08		398.4	308.0

TABLE 2.—*Effect of zinc soil applications on potato yields.*

Treatment	Pounds per Acre	Pounds Zn per Acre	Bushels No. 1 Tubers			
			G.Mt.[1] 1952	Kes. 1952	G.Mt. 1953	Ken. 1953
Check			323.7	316.2	285.7	297.4
$Zn\ SO_4.7H_2O$	28.8	6.55	362.2	327.7	288.3	
$Zn\ (C_2H_3O_2)_2.2H_2O$	28.8	8.58	376.8		301.5	312.0
Zn O	14.4	11.57		331.3	310.5	340.0

[1]Abbreviations are for Green Mountain, Keswick, Kennebec.

sprays were applied. The plots of Irish Cobbler potatoes were 4 rows wide by 40 feet long (50 feet in succeeding years), and each treatment was replicated 6 times. Five applications were made, the dates being July 13, 25, August 3, 14, 24. Unfortunately, the planting was made prior to the beginning of a dry, hot period and the plants made slow growth during the early part of the season. Later in the season the foliage was attacked severely by both early blight (*Alternaria solani* (E & M) Jones & Grout) and late blight (*Phytophthora infestans* (Mont) de Bary). This combination of meteorological and disease conditions probably interfered with the actual experiment — effect of zinc on yield — but an interesting tangent developed. It was observed that zinc sulphate, when applied alone, has some fungicidal value; and when zinc sulphate is incorporated with basic copper sulphate the fungicidal value of this copper spray is increased. These same observations were recorded in the tests of 1951, 1952, and 1953, and they are presented in table 3.

The yield results are too variable to determine whether or not zinc-containing sprays exert any influence on the yield of tubers as shown in table 4. In each of the years late blight attacked the foliage and therefore it may be expected that differences in yield were influenced by defoliation and by the measure of disease control achieved by the several spray mixtures. It is probable that no conclusion in this phase of the study will be possible until a year of no disease is encountered, or until a variety entirely resistant to late blight is available. The resistant varieties employed in these experiments were field resistant when first tested in the province, but they were soon overtaken by the biologic races that attack them.

Summary

Five years' results on studies of the effect of late blight control and on yield of potatoes of including zinc sulphate in the regular copper spray, and of the effect on yield of treating seed pieces in solutions of zinc salts and of incorporating zinc compounds with the soil, are reviewed in this introductory paper.

In two greenhouse tests, the rate of plant emergence was increased by soaking the seed pieces for one minute in a solution of zinc sulphate before planting. The same effect was observed in field plots in 1950, but it appeared that the more rapid emergence and the better growth were induced by the control of seed piece decay rather than by the nutritive value of zinc. No differences in emergence rates or growth rates were observed during the period 1951-1953, when both the sulphate and acetate of zinc were used.

The yield data for 1951, 1952, and 1953 show that seed pieces soaked for one minute in 0.08N solutions of zinc sulphate produced higher yields than seed pieces soaked in distilled water, and in 0.08N hydrogen sulphate; similarly, seed pieces treated in like solutions of zinc acetate produced higher yields than seed pieces soaked in distilled water, and in hydrogen acetate.

The yields of the potato varieties employed were increased by drill applications of zinc sulphate at 28.8 pounds per acre, of zinc acetate at 28.8 pounds per acre, and of zinc oxide at 14.4 pounds per acre.

TABLE 3.—*Foliage infection.*

Treatment[1]	Cob.[2] 12/9/50	Percentage Defoliation				
		G. Mt. 2/9/51	Kes. 10/9/51	G.Mt. 30/9/52	G.Mt. 15/9/53	Ken. 15/9/53
Check	100	100	100	77	100	92
Zn $So_4.7H_2O$ 2-80[3]	94	99	88	17	66	17
Basi-Cop 3.5-80	77	.....	.....	.....	.....	.....
Basi-Cop+Zn 3.5-2-80	57	.....	.....	.....	.....	.....
COCS 4-80	.....	68	72	.....	.....	.....
COCS+Zn 4-1.5-80	.....	65	63	.....	.....	.....
Bord. 8-4-80	.....	.....	.....	1	6	3
Bord+Zn 8-4-2-80	.....	.....	.....	trace	5	2
Bord+Zn 4-4-4-80	.....	.....	.....	0	6	2

[1]Number applications: 1950, 5; 1951, 5; 1952, 6; 1953, 7.
[2]Abbreviations are for Irish Cobbler, Green Mountain, Keswick, Kennebec.
[3]80 Imperial gallons equivalent to 100 U.S.A. gallons.

TABLE 4.—*Effect of treatments on yield.*[1]

Treatment	Bushels per Acre of No. 1 Tubers						
	Cob. 1950	G. Mt. 1951	Kes. 1951	G. Mt. 1952	Kes. 1952	G. Mt. 1953	Kes. 1953
Check	229.9	197.5	195.4	316.2	340.5	248.9	361.3
$ZnSO_4.7H_2O$ 2-80	234.3	216.5	213.6	372.9	372.9	250.4	376.3
Basi-Cop 3.5-80	244.5	.....	.....	.....	.....		.....
Basi-Cop+Zn 3.5-2-80	257.4	.....	.....	.....	.....		.....
COCS 4-80	.....	241.0	218.8	.....	.....		.....
COCS+Zn 4-1.5-80	.....	247.7	224.2	.....	.....		.....
Bordeaux 8-4-80	.....	.....	.....	402.8	359.0	272.1	355.3
Bord.+ Zn.8-4-2-80	.....	.....	.....	395.2	343.7	272.8	321.8
Bord.+ Zn 4-4-4-80	.....	.....	.....	378.9	368.5	305.5	386.4

[1]All varieties were attacked by late blight in each of the years; very heavy rains in June of 1952 resulted in considerable loss through seed piece decay, and the plants in some plots were stunted.

Spray tests indicated that zinc sulphate, when used alone, has some fungicidal value, and when incorporated with tribasic copper sulphate, copper oxychloride sulphate, and copper-lime sprays increases the efficiency of these fungicides.

In each of the years 1950, 1951, 1952, and 1953, late blight attacked the plants, and, in 1952, adverse weather in June caused considerable loss through seed piece decay. These factors may be expected to interfere with the main study — the effect of zinc-containing sprays on yield — and, although it is indicated that yield stimulation may occur, the final answer will not be obtainable until a year of no disease is encountered, or until a variety completely field resistant to late blight in this province is available.

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EFFECT OF POTASSIUM CARRIERS AND PHOSPHATE—POTASH RATIOS ON THE YIELD AND QUALITY OF POTATOES GROWN IN ORGANIC SOILS[1]

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Many organic soils are well adapted to the production of potatoes because of their high water holding capacity, good aeration, and favorable situation with respect to water table control. Sub-irrigation is possible in some cases and the loose condition of organic soils favors the formation of smooth tubers. There are two consumer objections to potatoes grown in organic soils. One is the prejudice against the black soil that adheres to the tubers. Washing has pretty well answered this problem. The second objection is poor quality, caused by a low starch content.

Generally speaking, the solutions to problems which affect quality in potatoes grown in mineral soils apply also to those which arise when the crop is grown in organic soils. One factor, the date of planting, has a marked effect on both yield and quality. In the early history of potato production in organic soils, late plantings were pretty much the rule. This was necessary to reduce leaf hopper damage and to help the plants escape danger of frost in the spring. Late plantings resulted in reduced yields, immaturity, and tubers low in starch. According to the findings of Smith *et al* (4), potatoes which matured in cool soils (60° or below) had a marked tendency to darken when cooked. Another factor affecting quality is plant nutrient balance. Excessive drainage of organic soils caused rapid oxidation which produced high nitrogen levels, a factor which tended to delay maturity. The fertilizer used was not proper for organic soils since potassium was generally the first limiting element in production.

Since large amounts of potash are applied to organic soils, the findings of American workers (2,3,5,6) and European workers on the effect of potash carriers on potato starch could have particular significance. The senior author, while agronomist at the William Gehring Farm in Indiana, started in 1948 large field tests comparing the two potash carriers, sulfate and chloride. On the Gehring Farm approximately 400 pounds per acre of potash (K_2O) was used annually for potatoes. This amount was much larger than growers commonly used on upland soil. The Irish Cobbler variety was used for the test. The per cent starch equivalents for chloride and sulfate fertilized potatoes were 13.4 and 14.5, respectively. No differences were noted in yields. To further determine the effect of sulfate and chloride on potatoes, four muck areas in Michigan were selected. Included in the studies were variations in the ratios of fertilizer phosphate and potash. It is the purpose of this paper to report these results.

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Chloride *vs* Sulfate

To compare the two carriers of potash, 0-10-30 was drilled at the rate of 1,000 pounds per acre. All the plots except those in Clinton County area were located in fields under commercial production. There was a total of 12 comparisons for use in the statistical evaluations. The color ratings were determined by the alcohol method (7) in which a rating of 8.0 is good and 1.0 is undesirable. Starch equivalents were determined by averaging values for the "floaters" in a set of salt solutions. The specific gravity values of the solutions were 1.064, 1.070, 1.076 and 1.088. The starch content was calculated from the specific gravity values using the equation of von Scheele *et al* (8).

Data in table 1 show the results of the two forms of potash. Average yields of all plots showed a small but nearly significant increase for sulfate over chloride (t value = 2.03; necessary at 5 per cent level = 2.06). The average starch content was increased from 12.3 to 13.4 per cent which is a 9 per cent increase in quantity of starch. (This difference was highly significant.) The increase in both yields and starch content produced a total increase of 15.7 per cent more starch per acre. This increase amounts to more than 500 pounds of starch per acre. The increase is very much in agreement with the results of other workers even though the total quantity of potash used in these tests was about double the amount used for upland soil tests. There was no significant improvement in color although the differences obtained in the potatoes grown in the Arenac County plots were quite marked.

The results obtained in 1953, shown in table 2, are very much in agreement with those obtained in 1952. The average starch content was 11.7 for potassium chloride and 13.2 for potassium sulfate. Little difference was noted in the color of the tubers as indicated by the alcohol test.

Effect of Varying Phosphate-Potash Fertilizer Ratios

The data shown in table 3 are the results obtained when different ratios of phosphate and potash fertilizers were applied at the rate of 1,000 pounds per acre. It will be noted that increasing the P_2O_5 application from 100 pounds to 200 pounds per acre caused little increase in yield whereas increasing the K_2O from 100 to 200 to 300 pounds per acre gave increasing values. The yield of potatoes fertilized only with phosphate was no better than that of those unfertilized at planting time. These results are in agreement with those obtained from past experiments on organic soils. For this reason, such fertilizers as 0-10-30 or 3-9-27 are recommended.

The percentage of starch was highest in potatoes treated with 1,000 pounds of 0-20-10 fertilizer, and lowest in those which received the 0-0-30 fertilizer. Those which received a fertilizer in the ratio of 1 to 3 (0-10-30) likewise were low in starch. The alcohol test showed that fertilizers high in potash resulted in better color. However, the differences were not significant. The 0-10-30 plots produced 3675 pounds of starch per acre and those treated with the 0-10-20 produced 3,960 pounds. These data indicated that 200 pounds K_2O per acre were sufficient to bring about maximum yields of starch.

TABLE 1.—*Effect of potash carrier on the yield, starch content, and color test of potato tubers grown on organic soils — 1952*

Location Variety	Bushel/Acre		Starch Equivalent Per cent		Color Alcohol Test	
	Cl—*	SO_4=**	Cl—	SO_4=	Cl—	SO_4=
Lapeer County						
Sebago	631	635	12.4	13.0	7.4	7.4
Allegan County						
Sebago	691	790	13.0	14.9	7.2	7.3
Cherokee	522	580	13.6	15.4	6.8	6.8
Arenac County						
Russet Burbank	365	382	12.1	12.4	3.4	6.6
Sebago	391	416	11.9	13.2	6.0	7.2
Clinton County						
Sebago	414	446	10.8	11.7	6.8	6.7
Average	502	532	12.3	13.4	6.3	7.0
Per cent Increase		6.0		9.0		

*Cl— = Potassium chloride fertilizer.
**SO_4= = Potassium sulfate fertilizer.

TABLE 2.—*Effect of chloride vs. sulfate on the starch content and color of potatoes — 1953.*

Source	K-carrier			
	Chloride		Sulfate	
	Starch Per cent	Color	Starch Per cent	Color
Arenac County				
Russet Burbank	14.0	7.00	14.8	7.60
Sebago	12.0	7.80	14.2	7.80
1363 Seedling	11.3	7.80	13.0	7.60
Allegan County				
Sebago	10.3	7.40	11.6	7.60
1363 Seedling	11.1	7.60	12.8	6.40
Clinton County				
Russet Burbank	11.7	6.90	12.6	7.10
Average	11.7	7.41	13.2	7.35

TABLE 3.—*Effect of fertilizer ratios on the yield, and starch content, and color of potato tubers.*

1000 Pounds Fertilizer	Bushels /Acre 1948-52	Starch Equivalent Per cent				Color Alcohol Test
		1950	1951	1952	Average	
0-20-10[1]	428	15.8	10.6	13.7	13.4	6.9
0-10-10[1]	437	15.2	11.0	13.6	13.3	6.9
0-10-20[1]	508	15.4	10.3	13.3	13.0	7.4
0-10-30[1]	531	13.0	10.2	11.5	11.6	7.2
0-0-30[2]	337	10.4	9.8	11.3	10.5	7.0
0-20-0[2]	100	.....	11.7	11.5	.....	7.4
No Fertilizer[2]	103	14.3	10.6	12.6	12.5	6.6

[1]Plots replicated five times. L.S.D. 5 per cent = 1.1 per cent starch.
[2]Single plot values.

Summary

Field experiments were established to study yields and quality of potatoes as affected by (1) sulfate *vs* chloride as potash carrier; (2) the effect of different phosphate-potash ratio fertilizers in the production of potatoes grown in organic soils.

It was found: (a) The fertilizer with 1-3 phosphate-potash ratio (100 pounds P_2O_5—300 pounds of K_2O per acre) produced the highest yield of potatoes but the potatoes contained 2 per cent less starch than did those fertilized with a 2-1, 1-1, and 1-2 ratio fertilizer; (b) Colors of the tubers as indicated by the alcohol test, however, were as good or better where the 1-3 ratio fertilizer was applied as where the others were used; (c) Potato tubers from the chloride-treated plots contained 1.3 per cent less starch and were 6 per cent lighter in weight than were those from plots treated with sulfate; (d) The total starch produced per acre was approximately 16 per cent greater from sulfate-treated potatoes than from those which received the chloride; (e) Location had a marked effect on the results obtained in the chloride *vs* sulfate comparisons.

It is recommended that potato growers should avoid the use of excessive amounts of potassium fertilizer, especially those containing the chloride if tubers with high starch content are desired.

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OBSERVATIONS ON THE LIPID CONSTITUENTS OF WHITE POTATOES[1]

M. E. HIGHLANDS,[2] J. J. LICCIARDELLO[3] AND S. F. HERB[4]

Dehydrated potatoes under certain storage conditions develop an off flavor which has been described as rancid, stale or hay-like.

Burton (2) reported that two types of deterioration could be detected in mashed potato powder which had been stored at different temperatures: First, the development of a brown color and charred taste and secondly, the development of an "off" flavor. He also found that increasing the storage temperature tended to accelerate the formation of both, but at the higher temperature the "off" flavor was masked by the charred taste. A high moisture content seemed to promote the first type of deterioration and retard the second.

In another paper Burton (3) ascribed the development of the "off" flavor to oxidation of the potato fat and presented as the basis for his conviction this evidence: (a) The fat was very unsaturated, having an iodine number in the region of 130. (b) Oxygen was absorbed during storage with only a negligible production of carbon dioxide. (c) Storage in an atmosphere of nitrogen inhibited the formation of the "off" flavor. (d) Increasing the moisture content also retarded the development of "off" flavor. This same effect is evidenced by the protective influence of high moisture content in retarding the fat oxidation in wheat flour and dried milk. (e) The development of "off" flavor was greatly accelerated by light which frequently enhances fat oxidation. (f) In some low-moisture samples the "off" flavor was accompanied by an increase in epihydrin aldehyde as detected by the Kreis test.

Volksen (7) conducted some preliminary experiments on potato fat and ascertained the presence of linoleic, linolenic and palmitic acids from the melting points of their derivatives.

Winton and Winton (8) state that potato fat is present in an amount of 0.02-0.18 per cent of the fresh whole tuber.

Though the amount of fat present may be negligible from a nutrition standpoint, it is still sufficient to induce spoilage from rancidity. Therefore, the purpose of this investigation was to make a more detailed study of the character of potato fat to determine its susceptibility to oxidation and its role in the development of "off" flavors in stored dehydrated potatoes.

EXPERIMENTAL PROCEDURE

The raw material used for this study was white Katahdin potatoes grown in Aroostook County during 1952.

Lipid recovery. Using vacuum dried potatoes, approximately 50 pounds of sound, whole tubers were peeled in an abrasive peeler, diced into ⅜ inch cubes, washed in cold running water till free of surface

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starch and blanched for 6 minutes in boiling water. These potatoes were then dried in single layers in a vacuum oven maintained at 167°F. (75°C) and a 27.5 inch vacuum, to an approximate moisture content of 5 per cent. The dried potato cubes were ground in a burr mill to a size that passed through a 20 mesh screen and then extracted with petroleum ether (B.P. 35-60°C). Anhydrous sodium sulfate was allowed to remain in contact with the ether-lipid solution overnight to remove traces of water. The solution was then filtered twice through Whatman filter paper No. 40 and distilled under vacuum to recover the lipid material.

Using air-dried potatoes, 420 pounds from the same lot of Katahdin potatoes were given the same preliminary treatment as described for the vacuum-dried potatoes with the exception that these were dried in a forced-air tunnel dehydrator at a dry bulb temperature not exceeding 167°F (75°C). The final moisture content was determined by the vacuum oven method to be 5.3 per cent. The same procedure was employed for extracting the fat as that followed for the vacuum-dried potatoes. Forty-four and one-tenth grams of a brownish-yellow lipid material was obtained which represented a yield of 0.17 per cent on the dry basis and 0.02 per cent on the fresh whole basis less skin.

A portion of the lipid material dissolved in petroleum ether was adsorbed on a column consisting of a mixture of magnesium oxide and hyflo-supercel. Three colored bands appeared; an orange band, a pink band, and a yellow band. Elution with acetone removed the yellow band and the carotene content of the lipid was determined to be 0.022 per cent. The orange band and pink band remained unidentified. The lipid had an odor that could be best described as "earthy." Its consistency at room temperature was thick and viscous. This lipid was stored in a glass-stoppered flask under a nitrogen atmosphere, and kept in a refrigerator at 35.6°F (2°C) until further analysis.

Methods of Analysis. Unsaponifiable matter was determined by the procedure described by Jamieson (5). A reddish-orange substance was obtained with a resinous or varnish-like odor.

Upon removal of the unsaponifiable matter, the total mixed fatty acids were recovered by acidifying the aqueous layer containing the saponified material with a strong excess of 20 per cent sulfuric acid solution and extracting the acidified mixture with low-boiling petroleum ether. The petroleum ether extract was washed free of mineral acid, dried over anhydrous sodium sulfate, and finally, the solvent was removed by vacuum distillation. The fatty acids from both the vacuum-dried and air-dried potatoes were analyzed by a spectro-photometric technique (4).

The acid number of the mixed fatty acids was derived by a method very similar to that described by Jamieson (4), but which had been adapted to small samples by an E.R.R.L. modification.

The acid number was converted to neutralization equivalent (mean molecular weight of the fatty acids) by dividing the equivalent weight of potassium hydroxide in milligrams by the acid number.

The iodine number of the mixed fatty acids was determined at the E.R.R.L. by the Wijs method. Iodine numbers on other samples of mixed fatty acids were determined by the writer using the Hanus method.

The refractive index of the potato fat was obtained with an Abbe

refractometer in accordance with the procedure outlined in the A.O.C.S. (1).

The Fryer and Weston method (1) for determining the specific gravity of the fat was modified. A reference temperature of 59°F (15°C) was maintained and the density of the test solutions was adjusted with sodium chloride. The density of the solution in which the fat sample remained suspended was regarded as the specific gravity of the fat.

An accelerated stability test was conducted on the potato fat in a Fisher Isotemp oven maintained at 148°F (64.5°C). Peroxide values were determined by the Wheeler method as adapted by Riemenschneider *et al.* (6) for small samples. For comparison, parallel tests were conducted on a relatively unstable oil (olive) and a high-stability cooking fat (Swift's Triple X Vream).

Storage studies were conducted on defatted, dehydrated potato granules and control samples packed in screw-cap glass jars and No. 2 hermetically sealed plain tin cans. All samples were stored for 12 months at —0.4°F (—18°C), room temperature and 98.6°F (37°C). The moisture content of all was approximately 6 per cent.

Results and Discussion

The composition of the lipid material from both vacuum-dried and air-dried potato is presented in table 1. The lipid material gave a positive test for carbohydrates and also for sterols. The fact that the specific gravity is greater than one may seem unusual, but this could possibly be attributed to the high percentage of unsaponifiable matter. No sharp line of demarcation could be obtained in recording the refractive index, consequently the average of twelve readings was taken as the representative value.

The composition of the fatty acids from the two lipids is reported in table 2. Traces of performed conjugation were detected in the fatty acids indicating possibly that slight oxidation had occurred, but with fatty material containing linoleic and linolenic acids, it is rather difficult to

Table 1.—*Composition of potato lipid.*

	Vacuum-dried Potato	Air-dried Potato	
	Sample No. 1	Sample No. 2	Sample No. 3
	E.R.R.L.*	E.R.R.L.*	M.A.E.S.**
	Per cent	Per cent	Per cent
Unsaponifiable matter	13.95	11.5	12.37
Total mixed fatty acids	50.18	56.2	52.7
Ether insoluble	8.34	9.6	9.4
Water soluble after saponification	27.5	22.7	24.3
Refractive index 60°C.	.....	.....	1.4801
Specific gravity 15°/15°	.....	.....	1.0180

*Eastern Regional Research Laboratory.
**Maine Agricultural Experiment Station.

TABLE 2.—*Composition of the fatty acids of potato lipid.*

	Vacuum-dried Potato	Air-dried Potato	
	Sample No. 1	Sample No. 2	Sample No. 3
	E.R.R.L.*	E.R.R.L.*	M.A.E.S.**
	Per cent	Per cent	Per cent
Linoleic acid	41.3	39.1	.....
Linolenic acid	28.4	32.2	.....
Oleic acid	6.9	1.8	.....
Saturated acids	23.3	27.0	.....
Iodine number	158.9	160.1	128.5
Acid number	.....	199.8	193.3
Neutralization equivalent	.....	280.7	290.4

*Eastern Regional Research Laboratory.
**Maine Agricultural Experiment Station.

avoid slight oxidation. There appears to be no significant difference in composition between the two samples of fatty acids to indicate that the air-drying operation had any deleterious effect on the character of the lipid. However, it is interesting to note that a sample of the fatty acids from air-dried potato analyzed at the Maine Agricultural Experiment Station yielded an iodine number (Hanus) of 128.5 which would imply that some oxidation of the lipid had resulted from the air-drying operation. The high neutralization equivalent indicates that a large percentage of the fatty acids are of the order C_{18}. This value is much greater than would be expected for fatty acids from normal fat.

Results of the accelerated stability test are illustrated graphically in figure 1. Regarding olive oil as a relatively unstable oil, the fact that the stability curves for the olive oil and potato lipid practically coincide would seem to imply that the potato lipid is also of an unstable nature. Vream, which is rated as a stable fat, was still in the induction stage at the end of forty days incubation.

No "off" flavor or aroma typical of fat oxidation could be detected in any of the dehydrated potatoes packed in tin containers at any of the various incubation temperatures after a year's storage. However, in the samples held at room temperature and 98.6°F (37°C), a burnt flavor was present which was more pronounced in the controls and which was stronger at the higher temperature. It is possible that the "off" flavor was present and was masked by the burnt flavor. The refrigerated samples had a normal potato odor and aroma. Also, at these same temperatures the controls were slightly darker than the defatted samples. An "off" flavor and aroma did develop in the glass packed controls at room temperature and 98.6°F (37°C), but not in the defatted samples.

SUMMARY AND CONCLUSION

The composition of potato lipid was ascertained and the presence of linoleic, linolenic and oleic acids was revealed in large amounts which

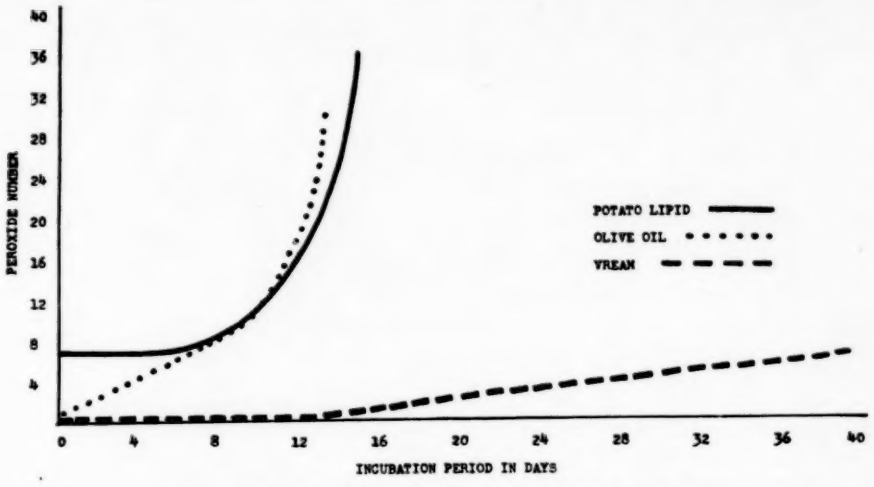

FIGURE 1.—Results of the accelerated stability test.

signified that the lipid had a highly unsaturated structure. Further evidence to support this indication was the determination of the iodine number of the fatty acids to be 158-160. Also, in an accelerated stability test conducted on potato lipid, olive oil and Swift's Triple X Vream at 148°F (64.5°C), the curve for the potato fat was almost superimposed upon the curve for olive oil which is regarded as an unstable oil.

Therefore, in view of these findings, it is proposed that the "off" flavor developed in dehydrated potatoes on prolonged storage results in part from the oxidative rancidity of the lipid material.

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SELECTION OF DESIRABLE SOMATIC MUTATIONS; A MEANS OF POTATO IMPROVEMENT[1]

JULIAN C. MILLER[2]

The plant breeder must use every means at his disposal to bring about improvement in the individual variety within a crop. After hybridization has been accomplished and a selection has been made, any further improvement within the asexually propagated selection must come about as a result of somatic mutations. Many of the leading horticultural varieties today, both fruit and vegetable, have resulted from such mutations. Space does not permit mention of all of these mutations, therefore, the present remarks will be confined to work with the Irish potato.

In 1929 Kotila (2) gave a report on some mutations of the potato. He described the abnormal fasciations in the leaves, stems and tubers resulting from mutations. Krantz and Bailey (3) also reported that mutations may occur in all parts of the plant. Webster and Rieman (7) described the unusual variations in the Sebago potato and stated that they found three different types of russeting and two abnormal vine characters and that all of these were perpetuated asexually.

Recently an article by Webb and Miller (6) reported on a red mutation of the LaSoda variety. H. O. Werner of the Nebraska Agricultural Experiment Station has selected early, medium, and late strains of Triumph, and Melvin Rominsky, Starks Farms, Rhinelander, Wisconsin, has selected many early, medium, and late strains of Chippewa.

In reviewing the history and development of American potato varieties, as described by Stuart (5) and Clark and Lombard (1), it may be noted that many of our present day varieties have resulted from somatic mutations. Some of these are listed below:

1. Russet Burbank (Netted Gem)	Mutation of smooth Burbank
2. Cobbler	Mutation of Early Rose
3. Red Triumph	Mutation of regular Triumph H. M. Darling, Wis.
4. Red Warba	Mutation of Warba F. A. Krantz, Minn.
5. Russet Sebago	Mutation of Sebago G. H. Rieman, Wis.
6. Red Pontiac	Mutation of regular Pontiac J. W. Weston, N. Dak.
7. Red LaSoda	Mutation of LaSoda Charles S. Blackman, S. Dak. as reported by Webb and Miller

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The question now arises as to the best way to discover these mutations. Should one find, through his breeding program, an outstanding seedling regarding yield and disease resistance, but lacking in a certain character, (for example, desirable skin color), the procedure would then be to grow a large population of potatoes from the new seedling and carefully examine all the potatoes harvested thereafter as to color. It will probably take a minimum of 40 or 50 acres, or even more, to expect to find many types of mutations occurring in the new seedling. Judging from the writer's experience, one will find quite a number of mutations varying from dark red skin to white skin and in degree of vigor of the individual plants. It will therefore require close observation and study to find these variants and to further test them regarding their yielding ability and for other desirable characteristics. For example, in the case of sweet potatoes in carefully selected seed stock, one visible mutation occurred in every 10,000 hills planted (4).

Another procedure, which would probably be better than that mentioned above, would be to follow the system now used in growing foundation stock. A large tuber unit planting is made; the vigor of individual hills and yield of the units throughout the season are studied; and at harvest time the character of the tubers themselves is noted.

A third suggestion as to how these selections might be located would be through careful observation at the washing and grading table. As the potatoes are passing over the washer and grader, the handlers should be encouraged to select unusual types, for later observation and study by the plant breeder.

In the past, certain plant breeders and geneticists have disregarded the importance of the selection of mutations. However, the weight of evidence, as presented here and elsewhere, is proof that the selection of outstanding mutations has resulted in the development of many of the important present day varieties. Since the varieties mentioned above constitute a large percentage of the potatoes now grown in the United States, it leads one to appreciate the importance and significance of selecting outstanding mutations.

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SUITABILITY OF SOUTHERN GROWN POTATO VARIETIES FOR PROCESSING[1]

WILLIAM A. SISTRUNK, RAYMON E. WEBB, AND JULIAN C. MILLER[2]

The processing of potatoes in the United States is receiving more attention each year. Approximately twenty-two million of the three hundred million bushels of potatoes that are produced annually in the United States are processed in various ways (6).

Very little information has been written concerning the canning of potatoes and the suitability of the different varieties, although canners have been encouraged to pack this item in recent years because of the increasing consumer acceptance.

Pre-peeled potatoes have been highly publicized for restaurant and hotel use in the last four years particularly. According to Olson and Treadway (7) the pre-peeling of potatoes cannot be standardized so that one formula will fit all conditions. Since raw material, processing equipment, packaging material, and storage conditions are variable, any one or combination of these factors will influence the final product. They suggest a thirty-second dip in a 1.7 per cent solution of sodium bisulfite or a 0.5 per cent sodium bisulfite and 0.5 per cent citric acid combination as treatments for preserving peeled potatoes when stored in cold storage.

The freezing of potatoes has been one of the most widely used processed potato products, particularly French fries. This item has been placed in frozen food display cases throughout the country and certain packers are making a specialty of this product (9).

Bewell (1) found that poor quality potatoes were almost as good for French frying as good quality potatoes and that high specific gravity was usually associated with good quality. Theissen (8) reported that during favorable growing conditions, potatoes of excellent quality were grown on both dry and irrigated land. Also, varieties varied in their ability to accumulate sugar during storage. This sugar accumulation caused a disagreeably sweet flavor after cooking and produced poor quality French fries of dark brown color. Deterioration in storage was apparently coupled with soft, soggy, sweet and watery potatoes (8).

Denny and Thornton (2) have shown that glucose is the main factor influencing discoloration in the last stages of potato chip frying. It was found that by treating potato slices in warm water (140-160° F.) for five minutes, followed by fifteen minutes in cold water that practically all the reducing sugars, thirty-five per cent of the protein and seven per cent of the dry matter were removed (5). Also, in later work potato slices were extracted with a warm acid solution to remove the reducing sugars and subsequent addition of glucose to produce the desired color (3, 4).

The authors feel that it will be of value to the potato industry to point out the suitability of southern grown potatoes for canning, freezing, pre-peeled packaging and chipping. Also, these varieties have not been evaluated regarding their adaptability, attractiveness and acceptance for processing.

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Experimental Procedures

The potatoes for the canning tests were peeled by submerging them in boiling twenty per cent lye solution for three to five minutes. Then the samples were washed in a wire basket under a water hose, packed in No. 2 plain cans, filled with a salt brine, sealed and processed at 240° F. (10 pounds pressure) for forty minutes.

Freezing studies were conducted on potatoes that had been peeled by hand-paring. Then the potatoes were sliced into ⅜ inch strips, treated, packaged in polyethylene bags, frozen at —20° F. and stored at the same temperature.

Pre-peeled, treated and packaged potatoes were peeled by both hand-paring and lye-peeling. The lye solution was heated to 155° to 160° F. during the peeling process in order to prevent cooking of the outer tissue of the potatoes. Samples were treated and packaged in polyethylene bags and stored at 40°, 50°, 70°, and 85° F. Observations were made daily and these data were recorded at intervals where distinct changes could be noted.

Potato chips were prepared from freshly dug potatoes grown in the spring of 1953, at two locations in Louisiana. There had been no rain prior to harvest, and the potatoes appeared to be well matured. Comparative studies were made on potatoes grown in the fall of 1952, in South Dakota. Preparation for chipping consisted of slicing, treating in 140° F. hot water for thirty seconds, rinsing in cool tap water and frying.

Discussion of Results

Canning. The outstanding variety for canning among sixteen varieties and seedlings processed by this method was the variety "Cherokee." The cream-colored flesh of LaSoda and Kennebec and the lack of uniformity of peeling in Triumph detracted from the general appearance of these varieties. However, all varieties produced an acceptable quality canned product when evaluated by a taste panel.

Freezing. Apparently variety has little effect upon the freezing ability or freezing quality of potatoes except when certain textures are preferred for the various methods of cooking.

One problem was whether or not pre-peeled and treated potatoes could be frozen and stored as long as three months. The quality studies recorded in table 1 point out that chemically treated samples of potatoes are lower in quality than the check sample. The quality varied somewhat with the treatment, but the acid mixture or treatment two imparted an acid taste to the cooked product. Also, treatment one resulted in a dull medium brown color and soggy texture. The blanched sample in each of the varieties gave the better quality of French fries on color, flavor and texture.

Pre-peeled packaged. Various chemical mixtures were used for treating two varieties of peeled potatoes. The better combinations were used as examples in table 2. This process has been widely used for the preparation of potatoes chiefly for the hotel and institutional trade. There appears to be an increasing market for these "Readi-taters" in the south. Most of the stock for the processing plants is being shipped from northern

TABLE 1.—*Quality of French fried potatoes prepared from blanched and chemically treated samples after four months of frozen storage at —20 degrees F.*

Variety	Treatment	Color	Flavor	Texture	Comments
Kennebec	(1)	Med. brown, dull	Good	Med., good	Good
"	(2)	Med. brown, dull	Fair, Acid	Med., slight toughness	Fair
"	(3)	Bright golden	Very good	Soft, tender	Very good
"	Check (frozen)	Discolored, very dull	Off-flavor	Soggy, tough	Very poor
LaSoda	(1)	Med. brown, dull	Good	Soggy, fair	Fairly good
"	(2)	Med. brown, dull	Fair, Acid	Tough, fair	Fair
"	(3)	Bright golden	Good	Soft, tender	Good
"	Check (stored)	Dark brown	Fair	Soft, tender	Fair

Treatments: (1) 0.4 per cent sodium sulfite
0.2 per cent citric acid

(2) 0.4 per cent sodium sulfite
0.8 per cent citric acid
0.1 per cent ascorbic acid

(3) Blanched 90 seconds in boiling water

potato areas. Preliminary tests have shown that locally grown potatoes can be used for a part of this trade. Southern grown freshly dug and stored potatoes are adapted to the majority of common usages if handled properly.

The chemical mixtures shown in table 2 represent the combinations that have given the better results for preserving the color, storage life, and appearance. Note that treatment No. 2 which contained the higher percentage of acid was the most effective in retaining the normal flavor and longer storage life of the pre-peeled potatoes at 40° F.

The other temperatures recorded in table 3 were not so effective in preventing spoilage. Definitely any temperature above 50° F. was not safe when treating potatoes with these concentrations of the chemicals. Higher concentrations were more effective in preventing spoilage, but they imparted an undesirable acid flavor to the product and made the texture leathery when the samples were French fried.

Potato Chips. The results in table 4 show that the per cent recoverable chips varies with the variety. Some of these samples from Louisiana gave practically as many recoverable chips as the same varieties grown on the Louisiana Station's plots in South Dakota. These potatoes were not peeled before slicing. Therefore, the per cent recoverable chips was higher in most instances than commercial chippers can expect to obtain. Fat absorption appeared to be higher in the freshly dug local potatoes than in the South Dakota stock. Specific gravity apparently was not the limiting

TABLE 2.—*Storage life of pre-peeled potatoes at 40° F. treated with various chemical mixtures.*

Variety	Treatment	Length of Storage			
		1 Week	2 Weeks	3 Weeks	4 Weeks
			(Discoloration and Flavor)		
Triumph	*(1)	None Normal	Very slight Normal	Slight Normal	Spoiled Off-flavor
"	(2)	None Normal	Very slight Normal	Slight Normal	Spoiled Off-flavor
"	(3)	None Normal	None *Normal*	Very slight Normal	Slight *Normal*
LaSoda	(1)	None Normal	Very slight Normal	Slight Normal	Spoiled Off-flavor
"	(2)	None Normal	Very slight Normal	Slight Normal	Spoiled Off-flavor
"	(3)	None Normal	None *Normal*	Very slight Normal	Slight *Normal*
Kennebec	(1)	None Normal	Very slight Normal	Slight Normal	Spoiled Off-flavor
"	(2)	None Normal	Very slight Normal	Slight Normal	Spoiled Off-flavor
"	(3)	None Normal	None *Normal*	Very slight Normal	Slight *Normal*
Check					
(All varieties)		Browning after 24 hours		.....	Normal flavor Tissue partly suberized.

*Treatments: (1) 0.4 per cent sodium sulfite
0.2 per cent citric acid

(2) 0.4 per cent sodium sulfite
0.2 per cent citric acid
0.2 per cent ascorbic acid

(3) 0.4 per cent sodium sulfite
0.8 per cent citric acid
0.1 per cent ascorbic acid

factor responsible for chip quality. The structure of the cell wall seems to be one key factor that affects the texture of the finished chips. The waxy varieties ordinarily do not make as good quality chips as mealy varieties. There appeared to be no definite relationship between specific gravity and mealiness among these varieties. Color and flavor were influenced by variety and the amount of sugar present at the time of chipping. In samples that fried beyond a light brown color the flavor was slightly burnt. The standard for an excellent quality chip in this experiment was a chip with a light golden color, good potato flavor and a medium texture.

TABLE 3.—*Storage life of LaSoda variety of potatoes pre-peeled, treated and stored at 50, 70, and 85 degrees F.*

Treatment	50° F.	70° F.	85° F.
	(Discoloration and Flavor)		
After 3 Days			
Check	.....	.....	Brown, spoiled
*(1)	.....	.....	Slight, sour
(2)	.....	.....	Slight, normal
(3)	.....	.....	Very bright, normal
After 7 Days			
Check	Brown, normal	Brown, spoiled	.....
(1)	Bright, normal	Discolored, spoiled	.....
(2)	Bright, normal	Bright, slight sour	.....
(3)	Very bright, normal	Very bright, normal	.....
After 17 Days			
Check	Brown, suberized	(Mold spots on sample)	
(1)	Yellowish, spoiled	.....	.....
(2)	Slight yellow, normal	.....	.....
(3)	Very bright, normal	.....	.....

*Same treatments as table 2.

TABLE 4.—*Chipping qualities of varieties grown in Louisiana compared to the same varieties grown in South Dakota.*

Variety	*Color	*Texture	*Flavor	*Rating	Recoverable Chips	Specific Gravity
					Per cent	
(La) Red LaSoda	Fair	Med.	Good	Fair	31.3	1.074
(SD) " "	VG	Med.	Fair	Good	35.7	1.101
(La) Kennebec	Ex.	Med.	VG	Ex.	30.2	1.074
(SD) "	VG	Med.	VG	VG	36.5	1.104
(La) LaSoda	Good	Med.	Fair	Fair	31.7	1.064
(SD) "	Good	Coarse	Fair	Fair	32.7	1.097
(La) Cherokee	Good	Med.	VG	Good	32.0	1.066
(La) Triumph	Good	Fine	Good	Fair	32.5	1.065
(La) Pungo	Ex.	Med.	VG	Ex.	35.0	1.068

*Ex.—Excellent
*VG—Very good
*Med.—Medium
SD—South Dakota
La—Louisiana

Summary and Conclusions

Several varieties of potatoes that are grown in the south have been evaluated for their suitability for processing.

All varieties produced an acceptable quality canned product as evaluated by a taste panel.

The highest quality frozen potatoes for French fries were those that had received a blanching treatment before freezing.

Potatoes were pre-peeled, chemically treated and successfully stored as long as four weeks at 40° F. without any noticeable loss of flavor or change in color. Higher temperatures were not so effective for preserving the quality.

Louisiana-grown potatoes produced chips that were comparable in quality to chips made from South Dakota-grown potatoes. However, the per cent recoverable chips was higher in South Dakota grown potatoes because of the higher specific gravity.

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ABSTRACTS OF PAPERS PRESENTED AT THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA, ESTES PARK, COLORADO, AUGUST 25, 26, 27, 1954

A study of Corynebacterium sepedonicum of Solanum tuberosum as related to host resistance and spread by water—ARNOLD, GORDON.

Ring rot of potatoes caused by *Corynebacterium sepedonicum* remains a serious threat to the potato industry. Research was conducted dealing with the nature of resistance of certain potato varieties to ring rot using a pure culture of the causal organism by checking its development in extract media from several different ring rot susceptible and ring rot resistant varieties. No striking or consistent differences were noted in the ability of the various media to support the growth of the organism. This study suggests that the factor for ring rot resistance of potatoes is not necessarily connected with or a constituent of the juice.

Spread of the causal organism by water was investigated by applying water suspensions of the organism to the soil of potted greenhouse potato plants. Plant symptoms and Gram stain technique were used to determine the degree of infection. The treatment receiving 6 weekly applications of inoculum plus soil stabs had the greatest disease incidence which was highly significant compared to the check. Regardless of the system of inoculation used, all treatments caused plant infection. These data suggest that water can be a factor in the spread of ring rot and the chance of infection occurring is greatly increased if mechanical damage occurs to the underground portion of the potato plants before the bacteria carrying water is present.

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The effect of pollen aging on seed development in Solanum—BEAMISH, KATHERINE.

The effectiveness of *Solanum* pollen is reduced by long storage in refrigeration. Year-old pollen may function to produce some seeds but many flowers fall without showing any evidence of fertilization or else the fruits grow to a small size and eventually drop off. Pollen degenerates similarly but much faster if aged at room temperature and humidity. The longer the pollen is held, the fewer good seeds are produced. Yet microscopic examination shows that frequently even when no seeds are maturing normally the pollen has germinated and fertilization has occurred. The endosperm cells divide and the embryo may become several-celled. Eventually, both endosperm and embryo become vacuolate, cell division stops, and the young seed collapses. Apparently the pollen, either directly or indirectly, exerts an effect on the later stages of seed development.

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Parasitic aggressiveness and its relation to late blight tolerant potato varieties and the survival of the pathogen.—CASTRONOVO, ALFONSO, H. DAVID THURSTON, AND CARL J. EIDE.

A complex of characters referred to collectively as aggressiveness affects the survival of races of *Phytophthora infestans* and their relative pathogenicity on non-hypersensitive potato varieties. On such varieties, differences in infectiveness, incubation period, and sporulation have been found between parasitic races and between different isolates of the same

races. Sporangial germination varied so much that differences of genetic origin could not be determined with certainty. The source of sporangia, including small differences in the age of the medium on which they were produced, has a definite effect on their germination. Potato varieties differ in their susceptibility to infection by races to which they are not hypersensitive, and in the relative abundance with which such races sporulate on them. These host characters, probably related to tolerance or field resistance, are usually assumed to be little affected by differences among races of the pathogen. This assumption may be questioned in the light of demonstrated differences in aggressiveness among isolates of the fungus, and the possibility of the effect of highly aggressive races on such varieties must be reckoned with.

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A tissue culture method of studying the potato plant.—CHAPMAN, HAROLD.

Nodes from potato sprouts, rendered aseptic by treatment for twenty minutes in 12 per cent hypochlorite solution, have been successfully grown and repeatedly subcultured on White's media containing 0.7 per cent agar. New roots and stems are visible in the culture bottles within three days. Tubers develop in many of the cultures in about twelve weeks. The technique allows complete control of the composition of the medium and allows ready manipulation of other factors of the environment. Callus cultures of epidermal, cambial, and pith origin have been developed on the same media plus 10 per cent fresh coconut milk and 7 mg/1 2-4-D. Roots, but no buds, have differentiated from these callus cultures.

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The flagella of swarmspores of Phytophthora infestans (Mont.) deBary *as viewed with the phase and electron microscopes.*—FERRIS, VIRGINIA ROGERS AND H. H. LYON.

Examinations of living swarmspores of *P. infestans* with the phase microscope reveal paddle-like structures on many of the flagella. Further information concerning the structure of the flagella was obtained with the electron and phase microscopes.

One of the flagella is ciliated, and the other is not. Immediately after the swarmspores emerge from the sporangia they move about rapidly and no paddle-like structures are visible on the flagella. Later, as the swarmspores begin to swim more slowly, the flagella appear to roll inward from the tip and begin to resemble paddles. Often the flagella may be seen to roll up completely. Before germination occurs, the swarmspore stops its movement and the flagella, still resembling paddles, become detached and float away. Both time and temperature appear to be factors in the rolling up of the flagella and their detachment.

Electron micrographs were made of killed and fixed swarmspores with the flagella in various stages of rolling up; and a movie was made of the living swarmspores as they appear when the process is viewed with the phase contrast microscope.

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Histological study of suscept-pathogen relationships between Solanum demissum Lindl. *derivatives and Phytophthora infestans* (Mont.) deBary. —FERRIS, VIRGINIA ROGERS AND L. C. PETERSON.

The interactions between leaf tissue of *Solanum demissum* derivatives

and several races of *Phytophthora infestans* (Mont.) deBary were investigated histologically. Techniques for inoculation and incubation were standardized, and all plants were maintained at 18°C. following inoculation. The histological examinations were made on sectioned material and on cleared whole leaves.

In susceptible plants mycelium was found in tissue distant to the site of penetration within 17 to 28 hours following inoculation. In resistant plants short secondary hyphae were often seen between mesophyll cells near the site of penetration, but widely ramifying mycelium was never observed. In most of the resistant plants a necrotic response developed a few hours before such a response was evident in susceptible plants. Differences among the varieties were noted, however, in the rapidity with which a necrotic response developed.

Plants duplex for a given resistance gene were inoculated with races pathogenic to plants simplex for the same gene. The lesions on the duplex plants were different in appearance from those found on other plants, whether resistant or susceptible. A susceptible reaction was obtained in the duplex plant when a culture reisolated after serial passages through a plant of the same genotype was used as the inoculum.

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Distribution of races of Phytophthora infestans (Mont.) de Bary *in Canada.*—GRAHAM, K. M.

During 1952 and 1953, some 75 isolates of *P. infestans* were obtained from diseased potato tubers and tomato fruits received from the 10 provinces of Canada. Only Races 0 and 4 (international classification) were isolated from commercial potato varieties lacking genes for resistance. On varieties such as Canso, Keswick, Placid and Kennebec, carrying one or more genes for resistance, Races 1, 1.2, 1.4, and 1.2.4 were found. No clear-cut distinction between "potato" and "tomato" races was apparent. Races 0 and 4 were both isolated from tomatoes, while a third race, tentatively designated 1(T), was obtained from Snowflake potato, the tomato variety Rutgers, and from a cherry tomato carrying a single gene for resistance to Races 0, 4, and to all the other races hitherto obtained from potato. Race 1(T) behaved like Race 0 on the potato differentials, while isolates of Races 0, 1, 4, 1.2, and 1.2.4 all attacked Stokesdale tomato. There was some evidence that a few of the original isolates consisted of mixtures of races. After being purified by means of a single-zoospore technique, all races hitherto tested have behaved consistently.

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The apparent graft transmission of a factor causing tuber formation in potatoes.—GREGORY, LUIS E.

The effect of photoperiod and temperature on the growth and development of virus free potatoes of the variety Kennebec was studied at the Earhart Plant Research Laboratory at Cal Tech. High tuber yield was obtained when the plants were grown at a day temperature of 20°C. with 8 hours of natural light and a night temperature of 14°C. When grown at a day temperature of 26°C. with 8 hours of natural light, a night temperature of 20°C. plus 8 additional hours of 1000 f.c. maximum intensity artificial light, no tubers were produced. Cuttings removed from

plants induced to form tubers will also form tubers from the axillary bud at the base of the cutting, whereas no tubers are formed from non-induced cuttings, but instead the bud will grow into leafy shoot. An induced stem grafted to a non-induced stem, and the grafted stock and scion maintained under conditions which prevents tuber formation, will still cause the axillary bud at the base of the stock to differentiate a tuber in approximately seven days.

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The use of foreign introductions in the breeding of U. S. potato varieties.—HOUGAS, R. W. AND R. W. ROSS.

Foreign introductions, including both cultivated varieties and wild species, have played an important role in the development of American potato varieties. Of the 62 varieties released by the state and federal potato breeding programs, all but 6 have one or more foreign introductions in their pedigree. Fifty-three American varieties have Suttons Flourball, a variety introduced from England as P.I. (Plant Introduction) 12646, in their pedigree. Busola, a variety introduced from Austria and Poland as P.I. 33476 and 38357 respectively, is in the pedigree of 52 American varieties.

A total of 24 different foreign introductions have been used as parents in the breeding of the American potato varieties which have been released to date. These 24 introductions have contributed increased male fertility, outstanding resistance to economically-important diseases (especially to common scab and late blight) and have without doubt resulted in increased general productivity of the crop.

The potato breeding programs of the United States presently include a considerable number of more recent foreign introductions (in addition to the 24 that have already entered into the pedigrees of commercial varieties). These introductions are being used because they possess desirable characters not found in the commercial varieties of this country. The introductions carrying resistance to southern bacterial wilt, verticillium wilt, the golden nematode, X virus, Y virus, leafroll virus and frost are of particular interest.

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Some new findings concerning Phytophthora infestans.—HOWATT, J. L. AND P. N. GRAINGER.

Further investigations, utilizing a full set of Dr. W. Black's differentials have confirmed that race (1,2,3,4) of *Phytophthora infestans* (Mont.) DeBary has appeared in the Fredericton area of New Brunswick, Canada. During these investigations several modifications in the testing techniques were deemed essential in order to lessen the chances of error. Information relative to the behavior of *P. infestans* under definite environmental conditions have been studied and some obscure host-parasite relationships have been established. An account is given on the authors' findings with designated races of *P. infestans* which indicates that a number of so-called races of this organism are mixtures. The contention that specialized races tend to die out has not been substantiated. Certain potato genotypes which have been given equivalent status as differential hosts in the "International System" do not react similarly to certain races. Evidence is presented which shows that monosporous zoospore cultures behaved

in an irregular manner on certain differential hosts. Furthermore, there is evidence indicating heterogeneity in isolates even of monosporous origin.

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Pollen and pollination studies on Irish potatoes.—KING, J. R.

A method of pollination and of handling pollen for pollination purposes which is particularly well suited to Irish Potato breeding will be described.

The method includes the following steps: Collection of flowers from male parent plants; securing the pollen; preparing the pollen for pollination; the pollination procedure, itself; checking the viability of the pollen; and storing the pollen.

The talk (15-20 minutes duration) was illustrated with color slides.

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Better quality french fried potatoes.—KIRKPATRICK, MARY E.

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Vector feeding relative to leafroll resistance in potato varieites.—LOCKE, S. B.

Aphid counts on potato varieties conducted during five seasons at Pullman, Washington, revealed no correlation between the vector population occurring on a variety and the amount of leafroll infection taking place in that variety. Cage experiments, wherein uniform numbers of aphids were confined to small leaf areas on three leafroll resistant and two leafroll susceptible potato varieties, revealed no significant differences with respect to survival or increase of the aphids on these varieties. However, highly significant differences occurred in amount of injury to the leaf tissues resulting from aphid feeding. The two susceptible varieties showed low aphid-feeding-injury indexes, and two of the resistant varieties showed high aphid-feeding-injury indexes, suggesting that at least one type of field resistance is associated with sensitivity to aphid feeding. A third leafroll resistant variety showed a low aphid-feeding-injury index, indicating that a second type of field resistance is operating.

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Effect of temperature on the development of ring rot.—LOGSDON, CHARLES E. AND C. J. EIDE.

Temperature was a major factor contributing to the ring rot *(Corynebacteirum sepedonicum)* epiphytotic in Alaska in 1953. The inoculum potential built up during previous cool seasons plus the above normal temperatures of 1953 brought about losses varying from ten to fifteen per cent in the potato crop. Optimum temperature for growth of both an Alaska isolate and a Minnesota isolate of the bacterium in culture was about 15°C. on agar and also in liquid culture. Optimum soil temperature for the development of the disease (using the Minnesota isolate) was approximately 25°C. At 16°C. 87 per cent of the plants became infected, only 81 per cent developed symptoms and 28 per cent completely wilted. At 25°C. 100 per cent of the plants became infected and 87 per cent wilted completely. There was little difference in the percentages of infected tubers at these temperatures. Fifty per cent were infected at 16°C. and 55 per cent at 25°C. soil temperature.

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Certified seed potato control areas in British Columbia, Canada.—MAC LEOD, H. S.

Selection of desirable somatic mutations, a means of potato improvement.—MILLER, JULIAN C.

After hybridization has been accomplished and a selection has been made, any further improvement within the asexually propagated selection must come about as a result of somatic mutations. Many of the leading horticultural varieties today, both fruit and vegetable, have resulted from such mutations. In the past, certain plant breeders and geneticists have disregarded the importance of the selection of mutations, however, the weight of evidence certainly is proof that the selection of outstanding mutations has resulted in the development of many of the important present-day varieties. To-day six of the leading varieties of potatoes have originated in this manner. This leads one to appreciate the importance and significance of selecting outstanding mutations.

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Resistance of potatoes to Verticillium albo-atrum.—MUNCIE, J. H.

Laboratory culture tests were made on 110 seedlings and 8 commercial potato varieties to determine relative resistance to *Verticillium albo-atrum* under field conditions. The plants were grown in 10 hill blocks in soil artificially heavily infested with a composite culture of isolates of the pathogen from potato from several areas in the state.

Plate cultures from 20 tubers of each lot showed 24 seedlings and 1 commercial variety free of infection. Of the 94 infected tuber lots, 86 showed vascular browning at the stem end of the tuber. The pathogen was isolated also from non-discolored tissue from 18 tuber lots.

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Northern Peru, a possible new source of potatoes resistant to Phytophthora infestans.—OCHOA, C.

In 1952 more than 400 samples of cultivated, wild, and weed potatoes were collected in the previously unexplored zone of northern Peru. These are now maintained in the germ-plasm bank at the Experimental Agricultural Station of Huancayo, Peru. Taxonomic and agronomic studies of the material are in progress and will result in a clearer idea of the distribution of cultivated and wild species as well as their usefulness in potato breeding programs. In tests of resistance to the races "0", "1", "4", "1.4" and "2.4" of *Phytophthora infestans* made in the greenhouse at the Department of Plant Pathology and Botany of the University of Minnesota, *Solanum chiquidenum* Ochoa sp. nov. (inedit) and *S. piurae* Bitter, both from the North of Peru, were found to be immune from all 5 races. No resistance to late blight has been reported until the present time in the potato species of Peru, and it is very significant to have found this characteristic in the northern wild species. It is very desirable to make an exhaustive exploration in Ecuador, especially in the southern part where the native potatoes are unknown. It is highly possible that new species highly resistant to late blight will be found.

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The technology of potato granule manufacture.—OLSON, R. L. AND W. O. HARRINGTON.

The production of potato granules, a dehydrated mashed potato product, is in line with a growing trend in the processing of foods toward concentration and improved convenience for use. Several methods for

producing potato granules have been developed during the past 30 years. The only one of these methods currently in commercial use in this country is the "add-back" process. This process involves a recycling (adding back) of dried potato granules and mixing the recycled material with freshly mashed potatoes to form a friable moist powder of below 40 per cent moisture content. The moist mixture is held for a period during which moisture equilibration takes place and a reduction in starch solubility and swelling capacity occur. Upon drying under suitable conditions, the individual cells remain separated and substantially undamaged. Physical damage to the product may cause release of free soluble starch, which manifests itself as an undesirable rubberiness in the reconstituted product. Several variables in the process have been related specifically to this attribute of quality and others (*e.g.*, product yield and package density), providing useful information for process adjustment to improve the acceptability of potato granules.

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Selection of greenhouse-grown seedling potatoes upon specific gravity and tuber characters.—PETERSON, C. E.

Seedling potato tubers grown in 3-inch pots in the greenhouse were classified according to type, skin texture and specific gravity. Performance of subsequent field-grown single hills and observation plots was studied in order to determine if such seedling tuber characters might provide a reliable basis for selection.

Correlations between specific gravity of greenhouse tubers and first year hills were low ($r = 0.243$ and 0.207 in two tests). Between first year hill and second year observation row the relationship was closer ($r = 0.504$), but too low to provide a reliable basis for selection.

Based upon skin type, seedling tubers classified as smooth produced 16.9 per cent of first year hills with rough-skinned tubers while those classified as rough-skinned produced 30.3 per cent. Less than ⅓ of the hills from rough-skinned seedling tubers could have been discarded for rough skins, a proportion that would hardly make profitable the discarding of seedling tubers for rough skins.

Distinctly pear-shaped seedling tubers produced hills that were 34.3 per cent acceptable on the basis of tuber shape and 65.7 per cent that were discarded because of irregular or pear-shaped tubers. Hills produced from seedling tubers classified acceptable were approximately 75 per cent acceptable for tuber shape and 25 per cent were irregular and pear shaped. Seedling tubers classified as pointed and irregular produced 43.1 per cent and 62.0 per cent acceptable shapes respectively in the first year hills. Except for the most distinctly pear-shaped or pointed tubers it would seem that very little can be accomplished by selection of greenhouse grown seedling tubers.

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The reactions of four species of potato infesting aphids to insecticidal treatments.—POND, D. D., C. A. MOORE AND J. B. ADAMS.

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Differential reaction of potato hosts to foreign and domestic physiologic potato races of Phytophthora infestans.—PRISTOU, R., AND M. E. GALLEGLY.

Differential potato hosts and potato physiologic races of *P. infestans* reported by Black in Scotland and Mastenbroek in the Netherlands were brought together for comparisons with the United States hosts and races of Mills and Peterson. Included in the tests were three isolates from Canada. The differential hosts contained either one of four genes (R_1, R_2, R_3 and R_4) or combinations of them. The physiologic races and genes for resistance reported by the above workers fell into a definite pattern. The results confirm the interrelationship of genes and races reported jointly by the above workers, and show that their proposed international system of designating these genes and races is valid and workable at present. Isolates of the above workers fell into ten groups matching the international races 0; 1; 2; 4; 1,2; 1,4; 2,4; 1,2,4; 1,3,4; and 2,3,4. The Canadian isolates tentatively identified by Black were found to be races 1, 2, 3,; 1,2,4 and 1,2,3,4. These 12 different races together with three others (3, 1,3 and 3,4), described by Black but not available for study, bring the total number of races found to 15. Only race 2,3 is missing from the 16 races identifiable with the present differential hosts.

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An association of late-breaking virus in potatoes with a phyllody condition in Ladino clover.—RAYMER, W. B. AND CLARK R. AMEN.

An unusual disease of potatoes appeared in central Oregon in 1946 and was described as the late-breaking virus disease. In many fields infection ranged from a trace to 3 per cent. In 1950 a marked increase in the prevalence of the disease occurred coincident with an increase in acreage of Ladino clover. A 1953 survey showed an average disease incidence of 12 per cent with individual fields as high as 36 per cent. A phyllody condition was general in adjacent Ladino clover fields. Further investigation revealed a proliferation of lateral buds and phyllody in species of *Lactuca, Brassica,* and *Erigeron* growing as weeds. Aster leafhoppers from these fields were fed on China asters, celery, lettuce, and White Rose potatoes. Aster yellows symptoms were produced on all but the latter which showed symptoms described for the late-breaking virus. This virus appears to be a strain of the aster yellows complex. Field spread of the disease is correlated with movement of the leafhoppers to the emerging potatoes when clover is clipped in the spring. A hairsprout condition consistently associated with the disease has not been found associated with other potato diseases in Oregon.

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Turgidity cycle in potato leaves throughout a 76-hour period.—RIDDELL, J. A. AND H. O. WERNER.

With sets of leaf discs acquired from Progress plants at four-hour intervals at Scotts Bluff, Nebraska during a 76-hour period maximum per cent relative turgidity (R.T.) values were found to occur at 2 A.M. and minimum values at 2 P.M. The correlation coefficients between accumulative water losses from black atmometers (B.A.L.) during 4, 9, 24, and 33 hour periods and per cent R.T. values determined at the ends of these periods, were found to be highly significant. R.T. values appeared to be influenced not only by conditions occurring shortly before sampling but also by those occurring earlier, even the previous day.

Blondy, a yellow-green somatic mutation in the Chippewa potato.—RIEMAN, G. H., D. C. COOPER AND DONALD A. YOUNG.

A yellow-green somatic mutation named blondy was found in an 8-acre tuber unit field of Chippewa potatoes. Approximately 3000 hills of the blondy mutant involving 64 clonal lines were studied over a period of 5 years. All blondy plants were found to be mosaics showing an array of normal green leaf areas ranging in size from pin head to entire branches or occasionally entire hills. A total of 7 normal green hills were observed in the blondy clonal lines. Four of these produced normal green clonal progenies and 3 produced blondy clonal progenies. Eight hills with both normal green plants and blondy plants were carefully lifted and the tubers from each type of plant were progeny tested. Of these, 2 hills produced true breeding normal green and blondy progenies, 2 hills produced mixed progenies and 4 hills produced only blondy progenies. The normal green segregates produced more and better formed flowers than the blondy mutant plants. Parental normal green plants developed twice as many stomata on the upper leaf surfaces and only one-half as many stomata on the lower leaf surfaces as the blondy plants. However, the blondy stomata were greatly reduced in size, were more variable and many appeared to be non-functional. Two yield trials involving six 30-hill replicates were made. The yielding ability of the blondy mutant strain was lower than the normal green parental strain. All stocks were free from virus diseases except virus X. Somatic mutants of this kind which are not readily observed in tuber unit seed programs may account for the gradual loss of yielding ability of many potato varieties.

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The inhibitory effect of phenolic compounds on the growth of Streptomyces scabies in culture medium.—SCHAAL, LAWRENCE A. AND GESTUR JOHNSON.

Three parasitic races of *Streptomyces scabies* were grown on Czapek's agar adjusted to pH 6.0, 7.5 and 8.5 to which the following phenolic compounds were added: chlorogenic acid 2, 4, and 6 mgs; caffeic acid 1, 2, and 3 mgs; Catechol 1, 2, and 3 mgs; parahydroxybenzoic acid 1, 2, and 3 mgs; and tetrahydroxybenzoic acid 1, 2, and 3 mgs per 20 cc of agar medium. Inhibition of growth was more pronounced at pH 8.5 than at pH 6.0. Growth of the most parasitic race was depressed less than the mildly parasitic race. These results indicate that the important role chlorogenic acid plays in scab resistance is due mainly to the production of quinones by enzyme action in the tuber. In culture medium increased inhibition was noted at the higher pH where auto oxidation of the phenolic compounds occurred and the subsequent production of quinones was higher.

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The variation of reducing sugar content in different varieties of potatoes.—WATADA, A. AND R. KUNKEL.

The changes in reducing sugar content as influenced by storage temperature were studied in fifty-four varieties of potatoes by two methods of chemical assay.

The two methods of chemical assay were in excellent agreement when sugar solutions made of reagent grade glucose were tested, but

they differed appreciably when applied to potato extracts. The degree of difference was influenced by the previous storage temperature which influenced the amount of reducing sugar.

The reducing sugar content increased in all varieties during storage, especially cold storage, but decreased when the storage temperature was increased. The differences between varieties ranged from five per cent to thirty-five per cent.

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Anomalous tuberization of Solanum tuberosum.—WERNER, H. O.

After seed production was well underway from the flowers produced in the seed production program referred to in the previous paper, the removal of vegetative buds was discontinued or prosecuted with less vigilance. Thereafter tubers were formed by these carbohydrate gorged plants from practically every remaining vegetative bud regardless of the location on the plant or the old parent seed piece. Numerous tubers were formed from buds in inflorescences. Primordia of inflorescences and complete flowers were developed from some tubers developing in terminal positions. Many of these anomalous developments were shown with colored slides.

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Enhancing blooming by preventing the formation of tubers.—WERNER, H. O.

By planting seed pieces in a high ridge, and washing the soil away to below the seed pieces when the plants were well established and then preventing the formation of tubers by removing all lateral buds as they appeared, blooming and berry production were greatly enhanced when using a 20-hour photoperiod and low greenhouse temperatures (day 70-75°, night 50-60°F.) from early January through April. With all lines (including some very "shy" bloomers) there was great improvement in the number of flowers per inflorescence, in the size of the individual flowers, and in the quantity and quality of the pollen. Practically all crosses made resulted in fruit and seed production. The berries were usually at least double the customary size and the seeds per berry were more numerous but apparently not larger than in former years.

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Storage research with the newly constructed storage at the Scotts Bluff Experiment Station.—WERNER, H. O. AND HARRIS, LIONEL.

The potato storage structure at the Scotts Bluff station was designed to determine how the desired low storage temperatures can be provided for the maximum number of days. The lines of investigation are designed to determine chiefly: A. The extent to which ground temperatures can be altered and utilized. B. The effectiveness of a cooling system in which air is continually circulated around bins but outside air is brought in through thermostatically controlled dampers only when it is required for cooling.

Some major results to date to be shown will be:

1. Graphs showing isothermic lines within sections of bins and of the ground beneath and adjacent to the storage for distances of 25 feet at several times throughout the season.

2. Photographs of tubers when removed from various parts of bins variously managed.

3. Graphic presentation of the record of the operation of the thermostatic controls in relation to the daily and weekly temperature records.

Four red and one white variety from the Nebraska potato breeding program.—WERNER, H. O. AND ROBERT O'KEEFE.

Brief descriptions of the characteristics and adaptability of the red varieties introduced by the Nebraska station throughout the past six years, Progress (1948), Sheridan and Dazoc (1953), Redglo (1954) and the white variety, White Cloud (1948).

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The effect of periodical potato top removal on yields.—WESTOVER, K. C.

During the period from 1945 to 1951, inclusively, four replicated trials of early (Cobbler) and six of late (Rural and Sebago) potatoes were in progress at the Reedsville Experiment Farm (1) to determine the rate of production during the growing season and (2) the length of season required to "make the crop." In each trial, beginning when the plants were in the early blossoming state and continuing until mid-fall the tops were removed from the plants in an equal number of randomized plots at 7- to 11-day intervals the first year and at 7-day intervals thereafter. In general, the data from these studies strongly suggest that, under the growing conditions in the intermediate altitudes of West Virginia, (1) few significant increases in yield occur later than 100 days after the crop is planted in the case of early potatoes (Cobbler) or (2) later than 120 days after the crop is planted with regard to late potatoes (Rural and Sebago).

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The interrelationship of potato and tomato races of Phytophthora infestans.—WILSON, J. B.

The reaction of 29 potato isolates of *P. infestans*, representing 10 different potato races were studied on tomato differential hosts, and 10 tomato isolates, representing 3 different tomato races were studied on potato differential hosts. The potato isolates fell into 4 groups: Group I, weakly to non-pathogenic on all tomato varieties; Group II, pathogenic on the recessive varieties Marglobe, Rutgers and Bonny Best, but non-pathogenic on minor-gene varieties Wisconsin "55" and #19 and dominant-gene varieties #36 and #106; Group III, pathogenic to the recessive and minor-gene varieties but not to the dominant-gene accessions; Group IV, pathogenic to all tomato varieties. Isolates of Groups II and III appear to differ only in degree of virulence. On potato hosts, the tomato isolates reacted as potato races 0, 3 or 4. One isolate of a given potato race may react as one tomato race, whereas another may react as a different tomato race. A similar relationship exists in regard to tomato races on potato. The tomato genes are different from any now known in potato; the race characteristic of a given isolate on potato should be considered independently from its characteristics on tomato.

POTATO NEWS AND REVIEWS

WHERE DO WE GO FROM HERE?[1]

ORA SMITH[2]

Potato consumption in the United States has been decreasing gradually for some years. In 1923 we consumed 172 pounds per person and reached a low of 96 pounds per person in 1952. During these 30 years there has been a decrease in yearly consumption of 76 pounds *per capita*. If the 1923 rate of potato consumption were maintained today, we would need 206 million bushels more than we now use. But the alarming decrease has occurred since 1947. During the last 6 years we have consumed 21 pounds fewer potatoes per person per year than the six year period just preceding this. This is an average of 57 million bushels per year that we should have maintained or should now try to recover.

Undoubtedly the quality of the potatoes on our markets is one of the reasons for this decline in consumption. Other possible reasons are (1) the notion that potatoes are fattening, and (2) there are many other foods now competitive with potatoes which were not on the markets until recent years or were there in small quantities. If the potato is to maintain its present rate of consumption or be increased, then some way will have to be found to make it as easily prepared for the table and as attractive to the consumer as are the many new and convenient food items, such as canned and frozen foods, pre-pared vegetables and other commodities. Such items as pre-peeled potatoes, canned potatoes, potato chips and sticks, frozen french fries, and dehydrated mashed potatoes help to fill this need.

"BEAUTY IS ONLY SKIN DEEP"

"Beauty is only skin deep" but never applied more appropriately than to our present-day potatoes. There has been no way by which the consumer could tell in advance what the cooking quality of any lot would be. Naturally, then, she chooses the potatoes that have the best external appearance. These are varieties such as Chippewa, Katahdin, and Sebago, rather than Green Mountain, Rural, and Cobbler. Hence, the switch from mealy varieties to less mealy varieties. The grower is easily converted to the newer varieties since yields of these usually are higher in many areas than from the older varieties.

Practically everything that has been done in the so-called improvement of potatoes has resulted in lowering their degree of mealiness. This, in no way, is criticism of potato breeders since they are constantly striving for increased mealiness. Much research and commercial effort has been expended in dressing up the exterior of our potatoes by working toward brighter skin, shallower eyes, regular shape, and by sizing, better packaging, brushing, washing, waxing, and now, in some sections by dyeing them. Much less has been accomplished to improve the edible portion. In other words, a fairly good job has been done to dress up that part of the potato which usually goes into the garbage. All of this improvement, I believe, would be commendable if simultaneously we improved the edible portion of the potato.

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[1]Presented at the Sixth National Potato Utilization Conference, November 17, 1954, Cornell University, Ithaca, N. Y.

[2]Professor of Vegetable Crops, Cornell University, Ithaca, N. Y.

Where would the egg industry be today if poultrymen had followed such a program of emphasizing improving the appearance of the shell, the inedible portion and given second place to improving the interior of the egg? Certain qualities of the edible portion of eggs were determined by the simple process of candling.

A "Look" into the Interior of the Potato

By persistent efforts to maintain freshness of eggs during handling and storage and by removal of less desirable eggs by candling, poultrymen have established the confidence of the consumer in their product. Similarly by the method of separating potatoes with salt solutions into various specific gravity groups, our industry can now "look" into the interior of the potato similar to egg candling and give consumers what they want in the way of mealiness of the cooked potato.

It is normal for potatoes to vary in specific gravity and mealiness; tubers from any one hill differ in this respect. Use of the specific gravity grader separates the non-mealy from the mealy potatoes in any lot regardless of variety or place where they are grown.

Although potato grades do not allow varietal mixtures, it is worse, as far as mealiness is concerned, to have in one package potatoes of one variety as they are normally grown than it would be to have several varieties in the same package but separated into one specific gravity group. It is just as important to have this separation as it is to have pastry flour and bread flour in separate bags.

Potato Industry "Watering Our Milk"

The trend in many foods is toward more concentrated products. Concentrated fruit juices are supplanting many of the more dilute forms. It is required by law that milk contain a minimum of 3 per cent butterfat and at least 11.5 per cent total solids. Maple syrup, by law, must weigh at least 11 pounds per gallon. These laws are attempts to insure that the customer is not deceived in what he or she is buying and they result in a guarantee to the consumer of a product of a minimum water content. Water is cheap. With potatoes, however, we guarantee only the exterior appearance of the tubers and the weight of the contents of the package and incidentally often fail to meet that. We leave the consumer entirely in doubt as to the cooking quality; that which is most important to her. As an industry we are still "watering our milk" and we seem to have the notion that if we put our product in an attractive package we are doing a good job of merchandising. One anonymous author in a recent article entitled "The Potato Goes Modern," has made the following statement, "Packaging has turned the tide of sales reverses for the industry." He further states that "Polyethylene helps retard greening of potatoes. This author probably knew exactly what he was doing when he remained anonymous.

Now I have nothing whatever against the use of an attractive package and the employment of all the other methods mentioned above to make the potato irresistible to the buyer — but that should be only one step in an attempt to supply the consumer with high quality potatoes. Unless and until we follow through and make a more determined and concerted effort to supply the consumers with potatoes of *better cooking quality* we

shall continue to be guilty of deceiving the consumer. Deceiving the consumer, even though it may be done unintentionally, will have disastrous effects eventually on the industry.

What Can We Do to Better Satisfy Our Consumers?

Select potatoes on basis of specific gravity for certain cooking purposes. Most consumers desire mealy potatoes for baking and for mashing but for boiling and serving whole these same customers want a potato which is not mealy, which will hold its form and not slough during boiling.

Potato chip processors and those processing frozen French fries desire mealy potatoes or those high in specific gravity. On the other hand, the potato canning trade must have low specific gravity potatoes, those which remain firm and whole after cooking. In fact, chemicals such as various calcium salts often are added for this purpose to the water in which potatoes are heated for canning. Thus, we see that consumers desire and should have potatoes that possess certain characteristics depending upon how they are going to be cooked or what they are going to be used for. There is no such thing as a general purpose potato because all varieties vary extensively within the same lot.

This demand can be met partially by selecting lots of potatoes on the basis of their specific gravity or total solids content using the potato hydrometer or any other satisfactory method. In this way, certain lots of potatoes could be located which are high in specific gravity and therefore could be especially advertised and marketed emphasizing their qualities for mealiness and their special adaptation to certain uses. Likewise other lots of potatoes low in specific gravity could be located in this manner and the special qualities of these potatoes be brought to the attention of consumers. Since these low specific gravity potatoes contain less starch they could be advertised truthfully to be "less fattening." Psychologically, however, this may not be a good form of advertising.

Specific Gravity Separation

Although this process of measuring the specific gravity of lots of potatoes and selecting them on this basis for certain uses is helpful, the method of separating lots of potatoes by salt solutions into specific gravity groups is still more valuable and far reaching. By this process, any lot of potatoes can be separated into groups and labelled and advertised according to their best cooking purpose, such as "Excellent for baking," "Guaranteed to be mealy," "Will not fall apart when boiled," *etc.*

Experiments of this nature were conducted in the Department of Vegetable Crops in the season of 1949-1950 indicating that consumers were willing to pay 7 cents more for 5 pounds of "Bakers" than for the same potatoes unseparated as to specific gravity without any reduction in volume of sales. Consumers also paid more for "Boilers" than for the same potatoes unseparated.

Experiments on a larger scale have been conducted cooperatively by the Department of Agricultural Economics and the Department of Vegetable Crops during the past 3 marketing seasons. Results of these studies will be presented to this group tomorrow. The important point is to remember that it is now possible, with our present varieties, to supply consumers with potatoes which, as far as mealiness is concerned,

will perform as desired when cooked in the proper manner. There is no doubt in my mind that this is one type of service which our industry could supply to consumers and which would be a step toward greater use of our product by the housewife, hotel, restaurant and other consumers.

Placing Varietal Name on the Package

I believe that the industry should feel obligated to gradually educate the consumers as to what constitutes good cooking quality, mealiness, etc., how varieties affect this and any other points which would create better public relations between grower and consumer. As an industry, we took quite a beating during price support years. The prices which we received and our income during those years were satisfactory but consumers and the public in general, looking at a few isolated and outrageous cases, put us down as the scalpers of the food industry. We must do everything possible to hasten the demise of such propaganda. One commendable approach to this is to do all in our power to supply the consumer with the best possible and to make it possible for her to consistently select potatoes which will best suit her needs.

I think we should start labelling our packages with the names of the variety which they contain. We all know that there are tremendous differences in the cooking qualities between varieties. We also are aware of the differences in cooking quality of the same variety grown under various conditions. But certainly, in the past, several areas have created an outstanding reputation for their potatoes on the basis of the combination of variety and growing conditions of that area. Green Mountains as grown in Maine and as grown on Long Island; Russet Burbank as grown in certain areas in Idaho are examples of this relationship between variety and location. It is now stated on the bags where the potatoes have been grown; by adding the varietal name on the package we would make it easier for the buyer to make repeat purchases of something she likes or to refrain from purchasing another lot of something which did not suit her needs. Through a period of years this educational feature gradually would enable these consumers to become more intelligent buyers of our produce.

More Research on Cooking Quality Needed

Another great need of our industry is much more research on the factors which determine cooking quality of potatoes and how these factors might be altered during growth and storage of the crop. More research should also be devoted to methods of potato processing which would result in improved quality of the processed product.

One of the most widespread undesirable qualities of potatoes is the tendency for the tubers to turn dark after cooking. In all surveys of consumers this defect is mentioned repeatedly and is considered one of the top problems on which more research is needed. The latest theory as to the cause of this type of darkening is that ferrous ions of the tuber combine with an o-diphenol giving a colorless or faintly colored compound. This compound oxidizes when exposed to air forming the deeply colored ferric compound. Mr. Muneta will report later this morning on fundamental chemical studies of after-cooking darkening in potatoes.

Two years ago we obtained the idea that after-cooking darkening of

potatoes possibly could be prevented by sequestering the iron in potatoes as a result of spraying plants in the field. A sequestering agent is a compound that will inactivate a metallic ion by forming a water soluble complex in which the metal is held in a non-ionizable form. A chelating agent is a compound which inactivates a metallic ion by making it an integral part of an inner ring structure. Since ethylenediamine tetraacetic acid (EDTA) and its salts chelate iron preferentially to all other commonly occurring metals it was selected for trial in our experiments. Other sequestering agents also were applied. When these potatoes were cooked in February and again in May it was found that several of the spray materials had reduced or prevented after cooking darkening.

These sequestering agents also have prevented discoloration of tubers when the chemical was applied to the peeled potato. This finding will be of tremendous importance to the future of the pre-peeling industry which is a rapidly growing portion of our overall industry.

Several of the chemicals applied to plants also have improved the color of chips made from these potatoes. This work also will be reported in more detail tomorrow. Any research which improves the cooking quality or processing quality of the potato is of great importance to our industry and is likely to result in increased use of our product. Further research along these lines, therefore, should be stimulated wherever possible. It is badly needed. Contrary to the statements of some folks our production problems are a long ways from being solved. We still must market what we grow and it is partly because of the poor quality of our crop that marketing is difficult.

Where we go from here, our present position, which is not too good, will depend largely on how we move our lines of attack forward. Our attack should be equal on all fronts, not some lines extended way beyond others. If we overextend our advertising and promotional programs and the improvement of the appearance of the potatoes but pay little attention to the edible portion of the potato, that quality upon which the consumer passes final judgment of our product, we are not doing the best job possible. It will never lead to completely satisfactory results. We need all the forces that we can muster to do a good overall job of selling potatoes to satisfied, repeat customers. Let's do it.

SIXTH NATIONAL POTATO UTILIZATION CONFERENCE BREAKS ATTENDANCE RECORD

All records for attendance were broken at the Sixth National Potato Utilization Conference held at Statler Inn, Cornell University, Ithaca, New York, November 17-18-19, 1954.

The Conference was sponsored jointly by the U.S.D.A., the United Fresh Fruit and Vegetable Association, and Cornell University, and the program was arranged under the Chairmanship of Dr. Ora Smith, Professor of Vegetable Crops, Cornell University.

Approximately 125 persons including potato growers, processors, and research workers from all sections of the United States and Canada were present.

An excellent program was presented dealing with such varied topics

as, the effect of fertilizers and crop rotations on specific gravity, marketing specific gravity graded potatoes, causes and cures of darkening of pre-peeled and cooked potatoes, effect of storage and sprout inhibitors on tuber quality, problems and new developments in the processing industry, sales promotion, consumer preferences, and production and utilization of the current crop.

The first of a series of the discussions, presented at the conference, to be published in the American Potato Journal is published in this issue.

LOANS FOR WATER SUPPLIES, IRRIGATION AND SOIL CONSERVATION AVAILABLE NOW

Loans for farmstead water supplies and irrigation systems were made available throughout the United States on September 1 and soil conservation loans will be available as soon as detailed instructions are worked out, Secretary of Agriculture Ezra Taft Benson announced recently.

Credit for farm irrigation systems and farmstead water supplies have been available in the 17 Western States since 1937. Legislation recently passed by Congress extended the water facility loans to the entire United States, authorized the new soil conservation loans, and provided government insurance for water facility and soil conservation loans advanced by private lenders.

The new soil and water conservation loan program, which includes both water facilities and soil conservation work, was authorized by Public Law 597, 83rd Congress, and will be handled by the Farmers Home Administration.

"This legislative measure is of extreme importance to American farmers," Secretary Benson said. "It will advance the conservation of our soil and water resources, help farmers and ranchers make good use of land diverted from the production of surplus crops, and enable many more farmers to develop irrigation systems and thus provide themselves with insurance against the hazards of drought."

Soil and water conservation loans may be made from funds supplied by private lenders and insured by the Government or from funds appropriated by Congress. Loans from appropriated funds will be made only when insured funds are not available. Loans, either direct or insured, will be made only when the applicant is unable to obtain the credit he needs at reasonable rates and terms from other sources. The Farmers Home Administration is authorized to insure loans up to a total of $25,000,000 each fiscal year. In addition, for fiscal 1955, the Congress appropriated $11,500,000 for this type of assistance.

Private lenders will receive a return of 4 per cent on insured loans; in addition the borrower will pay one per cent for insurance. Loans from appropriated funds carry an interest charge of 5 per cent.

Applications for all loans, insured or direct, will be made at the county offices of the Farmers Home Administration. There are approximately 1,500 of these offices serving all agricultural counties throughout the United States, Hawaii, Alaska, Puerto Rico and the Virgin Islands. The Farmers Home Administration will process and collect the payments on both insured and direct loans.

The 3-member county committees of the Farmers Home Adminis-

tration will certify the eligibility of applicants. Applications from veterans will receive preference in processing.

Loan funds may be used to pay the cash costs for materials, equipment and services directly related to the application or establishment of measures for soil conservation, water development, conservation and use, and drainage. This will include the construction and repair of terraces, dikes, ditches, ponds and tanks, the establishment and improvement of permanent pastures, basic application of lime and fertilizer, tree planting, well drilling, and the purchase of pumps and other irrigation equipment. Loans will be made to carry out only the types of soil and water conservation practices that are recommended by the Extension Service and the Soil Conservation Service.

Soil and water conservation loans will not be available for annual applications of fertilizer in the production of corn, cotton and other crops or for any other annually recurring costs that are generally considered as farm operating expense.

To be eligible for a soil and water conservation loan, a farmer must have sufficient experience or training to indicate that he has reasonable prospects of conducting successful farming operations and be unable to obtain the necessary credit on reasonable terms and conditions from private and cooperative sources.

Non-profit associations such as incorporated water associations, mutual water and drainage companies, irrigation and drainage districts, and soil conservation districts are eligible for a loan when they are unable to obtain adequate credit elsewhere and meet certain other conditions. For example, associations to be eligible must be primarily engaged in extending to their members services directly related to soil conservation, water conservation and use, or drainage of farm land.

The loans will be scheduled for repayment within the shortest period consistent with the ability of the borrower to repay. No loan will be scheduled for repayment over a period which exceeds the useful life of the improvement or the security, whichever is less. In no case will the repayment period on loans to individuals exceed 20 years. Loans to associations will be repaid on the same basis as indidivual loans but in exceptional cases can be amortized over periods up to 40 years. Each borrower will be required to refinance the unpaid balance of his loan when he is able to obtain a loan at reasonable rates and terms from other sources.

Individuals can borrow amounts up to $25,000. It is expected that the average loan to a farmer will be less than $5,000. Water facility loans last year averaged $4,500. Loans to associations have a ceiling of $250,000. All loans will be secured by the best lien obtainable on chattels or real estate to the extent necessary to adequately protect the Government's investment.

Applicants will obtain whatever engineering assistance they need from the Soil Conservation Service, Extension Service, other agencies, individuals and firms. Technical assistance of this sort from the Farmers Home Administration will be limited to a review of the engineering and economic soundness of the improvements to be financed. The Farmers Home Administration will also take whatever steps are necessary to make

sure that loans are used for authorized purposes and that the construction carried on with loan funds meets required standards.

When necessary, farmers who use loan funds to finance major land use adjustments and extensive reorganization of their farm business will receive assistance from the county supervisors of the Farmers Home Administration in the development and execution of sound farm and home plans.

BOOK REVIEW

THE POTATO IN HEALTH AND DISEASE

T. Whitehead, T. P. McIntosh and W. M. Findlay

Originally published in 1927 this third edition is a complete revision of the previous editions and is greatly expanded in scope containing 760 pages.

This comprehensive book covers a wide field. The first seven chapters are devoted to the botanical aspects of the potato including chapters on its origin and its introduction into Europe and descriptions of many varieties.

Potato breeding, cultivation, manuring and production machinery are all discussed in separate chapters.

The important problem of the cooking quality of potatoes is also covered. This is unusual in a general book on potatoes.

Four chapters are devoted to descriptions of and control measures for insects attacking the potato, whereas nine long chapters are devoted to the various diseases caused by bacteria, fungi, physiological conditions and viruses.

There are forty pages of references to the literature on potatoes, as well as an appendix on fungicides, another on descriptions of common commercial varieties and an index.

The book is most inclusive in its treatment of the subject of potatoes. Portions could well be used as a college text book, whereas other sections would be of value to seed or table stock growers and others interested in the Irish or white potato industry.

It is published by Oliver and Boyd, Edinburgh and London, and may be purchased from James Thin, 53-59 South Bridge, Edinburgh, Scotland at $9.00 or 60 £.

—John C. Campbell

USDA ISSUES GRADE STANDARDS FOR FROZEN FRENCH FRIED POTATOES

The U. S. Department of Agriculture recently issued United States Standards for Grades of Frozen French Fried Potatoes, the first to be formulated for this product.

The standards apply to Irish potatoes, prepared french-fry style, partially deep fried and frozen. The product as usually offered for retail sales is prepared for the table by heating it quickly in a hot oven. A quick additional deep-fat fry is usually recommended for the product when prepared for institutional use. The product covered by these standards has

developed in very recent years from a small volume specialty product to one of the staples of the frozen vegetable industry.

The principal factors of quality of frozen french fried potatoes are color, absence of defects, and texture. The grades are "U. S. Grade A" or "U. S. Fancy," "U. S. Grade B" or "U. S. Extra Standard," and "Substandard."

The standards become effective November 20, 1954. They are essentially the same as the proposals announced by the Department on May 20, 1954.